

WHAT IS CLAIMED IS:

1. A method of controlling carotenoid accumulation in at least one pineapple cell, the method comprising introducing at least one carotenoid biosynthetic polypeptide expression regulator into said pineapple cell, wherein said carotenoid biosynthetic polypeptide expression regulator controls accumulation of carotenoid in said pineapple cell.
2. The method of claim 1, wherein said pineapple cell is an embryogenic cell.
3. The method of claim 1, wherein said pineapple cell is an organogenic cell.
4. The method of claim 1, wherein said pineapple cell is an embryogenic callus cell.
5. The method of claim 1, wherein said pineapple cell is an organogenic callus cell.
6. The method of claim 1, wherein said pineapple cell is selected from the group consisting of: a Smooth Cayenne cell, a Red Spanish cell, a Perolera cell, a Pernambuco cell, and a Primavera cell.
7. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator increases accumulation of carotenoid in said pineapple cell relative to an accumulation of carotenoid in a pineapple cell that lacks said carotenoid biosynthetic polypeptide expression regulator.
8. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator decreases accumulation of carotenoid in said pineapple cell relative to an accumulation of carotenoid in a pineapple cell that lacks said carotenoid biosynthetic polypeptide expression regulator.

9. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator controls accumulation of one or more carotenoids that are selected from group consisting of: phytoene, phytofluene, ζ -carotene, neurosporene, δ -carotene, γ -carotene, α -carotene, β -carotene, apocarotenal, lycopene, canthaxanthin, zeaxanthin, and lutein.

10. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one organic molecule.

11. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one inorganic molecule.

12. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator comprises DNA.

13. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator comprises RNA.

14. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide, which nucleic acid segment stably integrates into the genome of said pineapple cell.

15. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide, which nucleic acid segment is linked to a selectable marker.

16. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide, which nucleic acid segment is operably linked to a constitutive promoter.

17. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that

encodes at least one carotenoid biosynthetic polypeptide, which nucleic acid segment is operably linked to an inducible promoter.

18. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that
5 encodes at least one carotenoid biosynthetic polypeptide that is selected from the group consisting of: an isopentenyl diphosphate isomerase, a geranylgeranyl pyrophosphate synthase, a phytoene synthase, a phytoene desaturase, a ζ -carotene desaturase, a lycopene β -cyclase, a lycopene ϵ -cyclase, a β -carotene hydroxylase, and an ϵ -hydroxylase.

10 19. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one sense nucleic acid segment that corresponds to at least a portion of at least one endogenous carotenoid biosynthetic polypeptide gene.

20. The method of claim 1, wherein said carotenoid biosynthetic
15 polypeptide expression regulator comprises at least one antisense nucleic acid segment that corresponds to at least a portion of at least one endogenous carotenoid biosynthetic polypeptide gene.

21. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that
20 encodes at least one carotenoid biosynthetic polypeptide transcription factor.

22. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide promoter and/or at least one carotenoid biosynthetic polypeptide enhancer, which nucleic acid segment
25 homologously recombines with at least one promoter and/or at least one enhancer of at least one endogenous carotenoid biosynthetic polypeptide gene.

23. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes a plant carotenoid biosynthetic polypeptide.

24. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes a bacterial carotenoid biosynthetic polypeptide.

5 25. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes an artificially evolved carotenoid biosynthetic polypeptide.

26. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide that is heterologous to said
10 pineapple cell.

27. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide that is homologous to at least one endogenous carotenoid biosynthetic polypeptide of said pineapple cell.

15 28. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that is introduced into said pineapple cell using Agrobacterium-mediated delivery.

29. The method of claim 1, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that is
20 introduced into said pineapple cell using at least one nucleic acid delivery technique selected from the group consisting of: pollen-mediated delivery, direct nucleic acid transfer to at least one protoplast of said pineapple cell, microprojectile bombardment, microinjection, macroinjection of inflorescence, whisker-mediated impregnation, laser perforation, and ultrasonification.

25 30. A pineapple cell produced by the method of claim 1.

31. The method of claim 1, wherein said pineapple cell is an organogenic cell produced by culturing at least one meristemic cell.

32. The method of claim 31, wherein said meristemic cell is a non-apical meristemic cell.

33. The method of claim 31, wherein said culturing comprises culturing said meristemic cell to produce at least one shoot, and culturing at least one explant from said shoot to produce said organogenic cell.

34. The method of claim 1, further comprising regenerating at least one pineapple plant from said pineapple cell.

35. The method of claim 34, wherein said pineapple cell comprises a population of pineapple cells and the method further comprises:

- 10 (i) selecting one or more members of said population of pineapple cells that comprise said carotenoid biosynthetic polypeptide expression regulator;
- (ii) regenerating one or more pineapple plants from said members; and,
- (iii) screening said pineapple plants for an accumulation of carotenoid that is altered relative to an accumulation of carotenoid in a pineapple plant that lacks said carotenoid biosynthetic polypeptide expression regulator.

36. The method of claim 34, wherein said altered accumulation of carotenoid is substantially specific to fruit tissues of said pineapple plant.

37. The method of claim 34, further comprising micropropagating said pineapple plant.

20 38. A pineapple plant produced by the method of claim 34.

39. A method of altering pineapple plant coloration, the method comprising introducing at least one carotenoid biosynthetic polypeptide expression regulator into at least one pineapple plant, wherein said carotenoid biosynthetic polypeptide expression regulator controls accumulation of at least one colored carotenoid in said pineapple plant, thereby altering said coloration of said pineapple plant.

40. The method of claim 39, wherein said pineapple plant is selected from the group consisting of: a Smooth Cayenne plant, a Red Spanish plant, a Perolera plant, a Pernambuco plant, and a Primavera plant.

5 41. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator increases accumulation of colored carotenoid in said pineapple plant relative to an accumulation of colored carotenoid in a pineapple plant that lacks said carotenoid biosynthetic polypeptide expression regulator.

42. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator decreases accumulation of colored carotenoid in said
10 pineapple plant relative to an accumulation of colored carotenoid in a pineapple plant that lacks said carotenoid biosynthetic polypeptide expression regulator.

43. The method of claim 39, wherein said colored carotenoid is selected from group consisting of: phytoene, phytofluene, ζ -carotene, neurosporene, δ -carotene, γ -carotene, α -carotene, β -carotene, apocarotenal, lycopene, canthaxanthin,
15 zeaxanthin, and lutein.

44. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one organic molecule.

45. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one inorganic molecule.

20 46. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator comprises DNA.

47. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator comprises RNA.

25 48. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide, which nucleic acid segment stably integrates into the genome of said pineapple plant.

49. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide, which nucleic acid segment is operably linked to a constitutive promoter.

5 50. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide, which nucleic acid segment is operably linked to an inducible promoter.

10 51. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide, which nucleic acid segment is operably linked to a promoter that promotes fruit-specific expression of said carotenoid biosynthetic polypeptide.

15 52. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide that is selected from the group consisting of: an isopentenyl diphosphate isomerase, a geranylgeranyl pyrophosphate synthase, a phytoene synthase, a phytoene desaturase, a ζ -carotene desaturase, a lycopene β -cyclase, a lycopene ϵ -cyclase, a β -carotene hydroxylase, and an ϵ -
20 hydroxylase.

53. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one sense nucleic acid segment that corresponds to at least a portion of at least one endogenous carotenoid biosynthetic polypeptide gene.

25 54. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one antisense nucleic acid segment that corresponds to at least a portion of at least one endogenous carotenoid biosynthetic polypeptide gene.

55. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide transcription factor.

5 56. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide promoter and/or at least one carotenoid biosynthetic polypeptide enhancer, which nucleic acid segment homologously recombines with at least one promoter and/or at least one enhancer of at least one endogenous carotenoid biosynthetic polypeptide gene.

10 57. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes a plant carotenoid biosynthetic polypeptide.

58. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that
15 encodes a bacterial carotenoid biosynthetic polypeptide.

59. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes an artificially evolved carotenoid biosynthetic polypeptide.

20 60. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide that is heterologous to said pineapple plant.

61. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that
25 encodes at least one carotenoid biosynthetic polypeptide that is homologous to at least one endogenous carotenoid biosynthetic polypeptide of said pineapple plant.

62. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator is injected into said pineapple plant.

63. The method of claim 39, wherein said altered coloration is substantially specific to fruit tissues of said pineapple plant.

64. The method of claim 39, further comprising micropropagating said pineapple plant.

5 65. A pineapple plant produced by the method of claim 39.

66. The method of claim 39, wherein said carotenoid biosynthetic polypeptide expression regulator is introduced into at least one pineapple cell from which said pineapple plant is regenerated.

10 67. The method of claim 66, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that is introduced into said pineapple cell using Agrobacterium-mediated delivery.

15 68. The method of claim 66, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that is introduced into said pineapple cell using at least one nucleic acid delivery technique selected from the group consisting of: pollen-mediated delivery, direct nucleic acid transfer to at least one protoplast of said pineapple cell, microprojectile bombardment, microinjection, macroinjection of inflorescence, whisker-mediated impregnation, laser perforation, and ultrasonification.

20 69. A pineapple cell that comprises at least one introduced carotenoid biosynthetic polypeptide expression regulator, which carotenoid biosynthetic polypeptide expression regulator controls accumulation of carotenoid in said pineapple cell.

70. The pineapple cell of claim 69, wherein said pineapple cell is an embryogenic cell.

25 71. The pineapple cell of claim 69, wherein said pineapple cell is an organogenic cell.

72. The pineapple cell of claim 69, wherein said pineapple cell is an embryogenic callus cell.

73. The pineapple cell of claim 69, wherein said pineapple cell is an organogenic callus cell.

5 74. The pineapple cell of claim 69, wherein said pineapple cell is selected from the group consisting of: a Smooth Cayenne cell, a Red Spanish cell, a Perolera cell, a Pernambuco cell, and a Primavera cell.

75. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator increases accumulation of carotenoid in
10 said pineapple cell relative to an accumulation of carotenoid in a pineapple cell that lacks said carotenoid biosynthetic polypeptide expression regulator.

76. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator decreases accumulation of carotenoid in said pineapple cell relative to an accumulation of carotenoid in a pineapple cell that
15 lacks said carotenoid biosynthetic polypeptide expression regulator.

77. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator controls accumulation of one or more carotenoids that are selected from group consisting of: phytoene, phytofluene, ζ -carotene, neurosporene, δ -carotene, γ -carotene, α -carotene, β -carotene, apocarotenal,
20 lycopene, canthaxanthin, zeaxanthin, and lutein.

78. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one organic molecule.

79. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one inorganic
25 molecule.

80. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator comprises DNA.

81. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator comprises RNA.

82. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid
5 segment that encodes at least one carotenoid biosynthetic polypeptide, which nucleic acid segment is linked to a selectable marker.

83. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide, which nucleic
10 acid segment is operably linked to a constitutive promoter.

84. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide, which nucleic acid segment is operably linked to an inducible promoter.

85. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide that is selected from the group consisting of: an isopentenyl diphosphate isomerase, a geranylgeranyl pyrophosphate synthase, a phytoene synthase, a phytoene desaturase, a ζ -carotene
15 desaturase, a lycopene β -cyclase, a lycopene ϵ -cyclase, a β -carotene hydroxylase, and an ϵ -hydroxylase.
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86. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one sense nucleic acid segment that corresponds to at least a portion of at least one endogenous carotenoid
25 biosynthetic polypeptide gene.

87. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one antisense nucleic acid segment that corresponds to at least a portion of at least one endogenous carotenoid biosynthetic polypeptide gene.

88. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide transcription factor.

5 89. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide promoter and/or at least one carotenoid biosynthetic polypeptide enhancer, which nucleic acid segment homologously recombines with at least one promoter and/or at least one enhancer of at
10 least one endogenous carotenoid biosynthetic polypeptide gene.

 90. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes a plant carotenoid biosynthetic polypeptide.

 91. The pineapple cell of claim 69, wherein said carotenoid
15 biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes a bacterial carotenoid biosynthetic polypeptide.

 92. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes an artificially evolved carotenoid biosynthetic polypeptide.

20 93. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide that is heterologous to said pineapple cell.

 94. The pineapple cell of claim 69, wherein said carotenoid
25 biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that encodes at least one carotenoid biosynthetic polypeptide that is homologous to at least one endogenous carotenoid biosynthetic polypeptide of said pineapple cell.

95. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that is introduced into said pineapple cell using *Agrobacterium*-mediated delivery.

5 96. The pineapple cell of claim 69, wherein said carotenoid biosynthetic polypeptide expression regulator comprises at least one nucleic acid segment that is introduced into said pineapple cell using at least one nucleic acid delivery technique selected from the group consisting of: pollen-mediated delivery, direct nucleic acid transfer to at least one protoplast of said pineapple cell,
10 microprojectile bombardment, microinjection, macroinjection of inflorescence, whisker-mediated impregnation, laser perforation, and ultrasonification.

97. A pineapple plant that is regenerated from said pineapple cell of claim 69.